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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/615,915	07/10/2003	Yohei Yamazawa	227430US26	9540

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EXAMINER	
DHINGRA, RAKESH KUMAR	

ART UNIT	PAPER NUMBER
1763	

NOTIFICATION DATE	DELIVERY MODE
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Please find below and/or attached an Office communication concerning this application or proceeding.

The time period for reply, if any, is set in the attached communication.

Notice of the Office communication was sent electronically on above-indicated "Notification Date" to the following e-mail address(es):

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Office Action Summary	Application No.	Applicant(s)	
	10/615,915	YAMAZAWA ET AL.	
	Examiner	Art Unit	
	Rakesh K. Dhingra	1763	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE *03* MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *04 May 2007*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1,3,4,6,11,18,19,28-30,41 and 45-55* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1,3,4,6,11,18,19,28-30,41 and 45-55* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *7/10/03* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☒ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☒ All b)☐ Some * c)☐ None of:

1.☒ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449 or PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: _____.

DETAILED ACTION

Response to Arguments

Applicant's arguments with respect to independent claims 1, 3, 4, 6, 1-16, 18, 19, 26-30 and 41-44 have been considered but are moot in view of the new ground(s) of rejection as explained hereunder.

Applicant has amended claims 1, 3, 4, 6, 11, 18, 19, 28-30 and 41 (for example in claim 1 new limitation are added – "between said one of the first and second electrodes" and "adjust a resonance state thereof relative to" and "into the first interconnection, and thereby set an impedance against the higher harmonic, the impendence setting section being" etc.)

Further, applicant has cancelled claims 2, 5, 7, 8, 12-16, 26, 27 and 42-44, and added new claims 45-55.

Accordingly claims 1, 3, 4, 6, 11, 18, 19, 28-30, 41 and 45-55 are now pending in the present application and are active.

New references - Hoffman et al (US Patent No. 7,030,335), Hirose (USPGPUB No. 2002/0007915) and Hilliker et al (US Patent No. 7,042,311), when combined with Roux et al read on amended claim 1 limitations.

Accordingly independent claims 1, 3, 4, 11, 28-30, 41, 45, 47-53 have been rejected under 35 USC 103 (a) as explained below. Further dependent claims 6, 18, 19, 46, 54 and 55 have also been rejected under 35 USC 103 (a) as explained below.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

(a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter

sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

This application currently names joint inventors. In considering patentability of the claims under 35 U.S.C. 103(a), the examiner presumes that the subject matter of the various claims was commonly owned at the time any inventions covered therein were made absent any evidence to the contrary. Applicant is advised of the obligation under 37 CFR 1.56 to point out the inventor and invention dates of each claim that was not commonly owned at the time a later invention was made in order for the examiner to consider the applicability of 35 U.S.C. 103(c) and potential 35 U.S.C. 102(e), (f) or (g) prior art under 35 U.S.C. 103(a).

Claims 1, 3, 4, 11, 28-30, 41, 45, 47-53 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raoux et al (US Patent No. 7,004,107) in view of Hoffman et al (US Patent No. 7,030,335), Hirose (USPGPUB No. 2002/0007915) and Hilliker et al (US Patent No. 7,042,311).

Regarding Claims 1, 41, 45, 51-53: Raoux et al teach a plasma apparatus (Figures 1, 5, 7, 11) that includes:

an airtight process chamber 30 that accommodates a wafer 36;

a gas supply system 89 and an exhaust system 88;

first and second electrodes 40, 32;

high & low frequency power sources 12, 17, high frequency matching unit 13, a processor 85 and an impedance tuner (impedance setting section), and an impedance probe 110 connected through a first interconnection to an electrode 22 to be electrically coupled to plasma. Roux et al further teach that an impedance probe 110 connected both to upper electrode side and to the lower electrode and the impedance tuner 108 are also in communication with the processor 85, and based upon input from the

impedance probe 110, processor 85 can adjust impedance setting of the impedance tuner 108. Raoux et al also teach that the impedance setting section (impedance tuner 108) with impedance probe 110 and the processor 85 can be configured to set a previously defined value of plasma impedance. Roux et al additionally teach that impedance tuner 108 (impedance setting section) can comprise a variable capacitor (Figure 11) or even a parallel LC circuit. Roux et al additionally teach that by controlling the capacitance of capacitor 20, resonance of higher harmonics can be controlled to tune the nature and concentration of the reactive species in the plasma. Though.Roux et al do not explicitly teach a matching network connected in the RF supply line to lower electrode, use of same is known in the art as per reference cited below (Hirose) to enable match the plasma impedance with the RF generator impedance for reducing RF power reflections {column 6, lines 10-25 and column 8, line 62 to column 9, line 40 and column 10, lines 45-65 and column 18, lines 12-62}.

Roux et al do not explicitly teach the impedance setting section being configured to adjust a resonance state thereof relative to a higher harmonic of a fundamental frequency of the RF power and which is input from the plasma into the first interconnection, and thereby set an impedance against the higher harmonic as a resonant target, and further that the impedance setting section comprises an impedance change unit connected to the first interconnection through a shunt and configured to select a higher harmonic as a resonance target, and a filter disposed on the shunt between the first interconnection and the impedance change unit and configured to and to cut a off the fundamental frequency of the RF power.

Hoffman et al teach a plasma apparatus (Figure 1, 8) comprising:

A chamber 100 with a wafer support 105 and an overhead electrode 125 that is supplied RF power from a RF source 150 through a coaxial cable 162 and a coaxial stub 135 with an inner conductor 140 and outer conductor 145. Hoffman et al further teach a thin insulative layer 360 disposed between overhead electrode 125 and base 290b of a conductive housing 290. Hoffman also teach that plasma

processing (etch rate) can be improved by selecting the capacitance (impedance) of insulative layer 360, so that the return path of plasma through overhead electrode 125 and coaxial conductor 140 is tuned for resonance with the second harmonic of bias frequency power supplied to lower electrode (column 4, line 45 to column 5, line 20 and column 20, line 20 to column 21, line 25).

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to adjust the impedance setting unit so as to obtain a resonance state between the plasma impedance and the higher harmonic of RF power as taught by Hoffman et al in the apparatus of Roux et al to obtain improved plasma processing.

Roux et al in view of Hoffman et al do not explicitly teach that the impedance setting section comprises an impedance change unit connected to the first interconnection through a shunt, and a filter disposed on the shunt between the first interconnection and the impedance change unit and configured to cut off the fundamental frequency of the RF power.

Hirose teaches a plasma apparatus (Figure 7) comprising:

an airtight process chamber 11 which accommodates the target substrate W;
a gas supply system, an exhaust system, first and second electrodes 12, 13 an RF power supply 14 connected to one of the first or second electrodes through a first interconnection and configured to supply RF power;

a matching circuit 17 arranged between said one of the first and second electrodes 12 and the RF power supply 14 on the first interconnection and configured to serve to automatically perform input impedance matching relative to the RF power;

a first filter 42 (impedance setting section) provided at the first interconnection 36 through a shunt, and where the filter circuit 42 is capable of varying the circuit constants through a variable capacitor 42a (paragraphs 0070-0078).

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to use the impedance setting section comprising of a impedance change unit provided at the first interconnection through a shunt as taught by Hirose in the apparatus of Roux et al in view of Hoffman et al to enable control impedance of plasma against the RF power being supplied by the matching circuit.

Roux et al in view of Hoffman et al and Hirose teach an impedance setting unit on the first interconnection through a shunt, and which comprises an impedance change unit, but do not teach that the impedance setting unit further comprises a filter disposed on the shunt between the first interconnection and the impedance change unit and configured to cut off the fundamental frequency of the RF power.

Hilliker et al teach a plasma processing system (Figure 3A) comprising:

A plasma chamber 225 with an auto-match 203A (impedance setting unit) that includes an auto-match circuit 310 (impedance change unit) and a filter 312 disposed on a shunt between the first interconnection and the impedance change unit 310. Hilliker et al further teach that filter 312 can be configured to pass energy at a desired frequency band and absorb the energy at other frequencies. Though Hilliker et al do not explicitly teach that filter 312 enables/allows higher harmonics to be passed through and cutting off the fundamental frequency, the same is a matter of configuring the filter as per process limitations (column 5, lines 8-68).

Therefore it would have been obvious to one of ordinary skills in the art at the time of the invention to use the impedance setting section comprising an impedance change unit and a filter disposed on the shunt as taught by Hilliker et al in the apparatus of Roux et al in view of Hoffman et al and Hirose to selectively allow frequencies of interest to be passed and block/absorb the other frequencies.

Regarding Claims 3, 4: Raoux et al teach that in the apparatus preset control profiles for each process can be stored in the software program in advance which result in improved uniformity and stability of the plasma process on the target substrate (Column 9, lines 40-55 and Column 21, line 60 to Column 22, line 15).

Regarding Claims 11, 47: Rouax et al in view of Hoffman et al, Hirose and Hilliker et al teach the value of the impedance set by the impedance setting unit (including impedance against the RF power) can be set (configured) and controlled as per process limitation, that is the impedance against RF power acts like a result effective variable, to obtain improved processing parameters like etching rate improvement (Column 18, lines 30-65).

Further it has been held in courts as follows:

It would have been obvious to one having ordinary skill in the art to have determined the optimum value of a cause effective variable such as through routine experimentation in the absence of a showing of criticality. *In re Woodruff*, 16 USPQ2d 1934, 1936 (Fed. Cir. 1990).

Regarding Claims 28-30, 48-50: Roux et al teach a second RF power supply 12 connected to upper electrode 40 at second interconnection and where the frequency of first RF source 17 (350-950 KHz) is lower than frequency of second RF generator 12 (13.56 MHz). Further, relative values of frequencies supplied by first and second RF sources are also dependent upon the type of process, apparatus configuration and other process limitations.

Claims 6, 46 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raoux et al (US Patent No. 7,004,107) in view of Hoffman et al (US Patent No. 7,030,335), Hirose (USPGPUB No. 2002/0007915) and Hilliker et al (US Patent No. 7,042,311) as applied to Claims 1, 45 and further in view of Collins et al (US Patent No. 6,252,354).

Regarding Claims 6, 46: Raoux et al in view of Hoffman et al, Hirose and Hilliker et al teach all limitations of the claim including that variable capacitor of the impedance tuner 108 (Raoux et al) enables impedance to be automatically adjusted (continuously varying element) in response from the impedance probe 110 to enable control impedance.

Raoux et al in view of Hoffman et al, Hirose and Hilliker et al do not teach impedance control stepwise by switching a plurality of fixed elements.

Collins et al teach an apparatus (Figures 5, 6) that uses plurality of switches 520, 520' which can be closed in different combinations to provide choice of resistive matching ranges to facilitate impedance matching and that various inductive and capacitive elements may be fixed or variable (Column 10, line 52 to Column 11, line 37).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use stepwise control of impedance as taught by Collins et al in the apparatus of Raoux et al in view of Hoffman et al, Hirose and Hilliker et al to provide optimization of plasma parameters.

Claims 18, 19, 54, 55 are rejected under 35 U.S.C. 103(a) as being unpatentable over Raoux et al (US Patent No. 7,004,107) in view of Hoffman et al (US Patent No. 7,030,335), Hirose (USPGPUB No. 2002/0007915) and Hilliker et al (US Patent No. 7,042,311) as applied to Claims 1, 45, 52, 53 and further in view of Hilliker (US Patent No. 6,631,693).

Regarding Claims 18, 54: Raoux et al in view of Hoffman et al, Hirose and Hilliker et al teach all limitations of the claim including that filter 312 is configured to pass energy at a fundamental frequency and block other frequencies.

Raoux et al in view of Hoffman et al, Hirose and Hilliker et al do not teach filter has a high impedance of not less than 50 ohm against harmonics other than a selected harmonic.

Hilliker ('693) teaches a plasma apparatus (Figures 2, 6) wherein a reactor 104 is connected with a filter network 102, through a matching network 103. Hilliker ('693) further teaches that filter network 102 isolates RF generator 101 from the plasma load and also stabilizes the voltage waveform seen by the plasma in the reactor. Hilliker ('693) also teaches that the filter circuit comprises parallel resonant circuit and can allow frequencies of interest (includes higher harmonics as) to be delivered to plasma and absorb the unwanted frequencies (including fundamental frequency of RF power). Hilliker ('693) additionally

teach that location of filter circuit 202 can be varied with respect to impedance matching elements 111 depending upon the type of applications. Hilliker ('693) further teaches that filter 102 (Figures 1) have a resistance of 50 ohm to enable dissipate energy at other than desired frequencies (Column 4, lines 26-53).

Therefore it would have been obvious to one of ordinary skill in the art at the time of the invention to use filter circuit with a high resistance of 50 ohm as taught by Hilliker ('693) in the apparatus of Raoux et al in view of Hoffman et al, Hirose and Hilliker et al to isolate the RF generator from energy of unwanted frequencies.

Regarding Claims 19, 55: Hilliker ('693) teaches that Filter circuit 601 (Figure 6) include a high pass filter 631 and a low pass filter 621 which can be set to cut any desired frequency including fundamental frequency component (Column 8, lines 25-67).

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL.** See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to Rakesh K. Dhingra whose telephone number is (571)-272-5959. The examiner can normally be reached on 8:30 -6:00 (Monday - Friday).

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Parviz Hassanzadeh can be reached on (571)-272-1435. The fax phone number for the organization where this application or proceeding is assigned is 571-273-8300.

Information regarding the status of an application may be obtained from the Patent Application Information Retrieval (PAIR) system. Status information for published applications may be obtained from either Private PAIR or Public PAIR. Status information for unpublished applications is available through Private PAIR only. For more information about the PAIR system, see http://pair-direct.uspto.gov. Should you have questions on access to the Private PAIR system, contact the Electronic Business Center (EBC) at 866-217-9197 (toll-free).

Rakesh K. Dhingra

Karla Moore
Primary Examiner
Art Unit 1763